CONSTRUCTION INDUSTRY INSTITUTE

The Owners' Role in Construction Safety

Research Summary 190-1

Construction Industry Institute

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The Owners' Role in Construction Safety

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Owners' Role in Construction Safety Project Team

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Executive Summary

Many parties are involved in the construction process: contractors, subcontractors, suppliers, designers, sureties, financial agencies, attorneys, accountants, engineers, consultants, and others. While each does not necessarily play a role in every project, one party invariably does, the facility owner. It would stand to reason that the owner would also have an influence on the safety performance actually realized on constructed facilities. But what is the nature and extent of the owner's influence on project safety performance?

CII funded this study to determine the role and influence that owners have in the area of construction safety. The research focused on the owner's involvement in safety management as demonstrated through the selection of safe contractors, inclusion of safety requirements in the contract, and active participation in safety during project execution. Improved safety performances are possible through the use of the following practices by owners:

- Careful selection of safe contractors.
- Contractual safety requirements.
- Proactive involvement in the safety practices of projects.
- Establishment of and funding for a safety recognition program.
- Active participation in safety training and orientation and verifying the comprehension of the training.
- Assigning a full-time safety representative on site.

The details of the research and the findings are presented in the following pages. Readers are encouraged to practice the concepts described and to set as the goal on every project that of zero accidents.

1

Introduction

This research was undertaken by conducting interviews and using a carefully developed questionnaire. The interviews were conducted with owners' representatives who had project safety responsibilities.

While most interviews were conducted in person, several were conducted as telephone interviews when distances were excessive or when the person being interviewed expressed a preference for a telephone interview. The person interviewed was generally the owner's top representative on the project who had a full-time responsibility for safety. The questions in each interview were focused on the practices that were employed on a single large project (half of the projects employed more than 550 workers), but some individuals gave responses representing the practices employed on a group of small capital projects. Projects were either ongoing or had been completed within the past two years. The interviews focused on obtaining information about the demographics of the projects, the manner in which contractors were selected, the types of safety-related provisions included in the contracts, and the type of owner involvement in project execution.

A total of 81 personal interviews were conducted. When the data were analyzed, a constraint was imposed such that projects included in the analysis must have had at least 100,000 hours of worker exposure. This was to ensure that the safety performance measures gave a reliable indication of the actual safety performance. Since some projects were in their early stages of construction, they did not have the requisite hours to satisfy the criteria for inclusion in the data analysis. By excluding the projects with fewer than 100,000 hours of worker exposure and those projects for which complete injury data were not provided, the final analysis included 59 projects.

2

Findings

Safety performances were measured by using the total number of OSHA recordable injuries per 200,000 hours of worker exposure, commonly known as the Total OSHA Recordable Injury Rate (TRIR). Whenever the term TRIR appears, it should be clear that the measure of safety performance consists of all OSHA recordable injuries, including lost-time injuries and restricted work injuries.

For the 59 projects included in the analysis, the average TRIR was 1.95, with six projects reporting zero OSHA recordable injuries. One of the projects reporting a TRIR of zero had amassed nearly 500,000 hours of worker exposure.

The results presented in this report are based on rigorous statistical analysis of the safety performances associated with each of the different responses. It is only when the differences of the TRIR means (or averages) are statistically significant that the results are presented, unless specifically noted otherwise. Statistical significance was assumed when the level of significance was 0.05 or smaller, meaning that there is less than a five percent probability that the finding is due to chance. Other findings that are presented are those in which the level of significance is between 0.05 and 0.10, being indicative of a tendency toward statistical significance.

Project Descriptions and Safety Performance

Project size descriptors (as measured in terms of worker hours and in total contracted project cost) and TRIRs of the 59 projects included in the final analysis are shown in Table 1. Of these projects, seven were in Canada, three were overseas with U.S. owners, and 49 were located in 18 states of the U.S (included in the U.S. total is one project in the U.S. Virgin Islands). The numbers of interviews conducted in different states are shown in Figure 1.

Table 1. Safety Performance and Size of Projects

	Total worker hours expended	Total estimated cost of the project	Total Recordable Injury Rate
Mean	2,426,210	$379,440,000	1.95
Minimum	100,000	$3,500,000	0
Maximum	26,300,000	$5,000,000,000	9.25

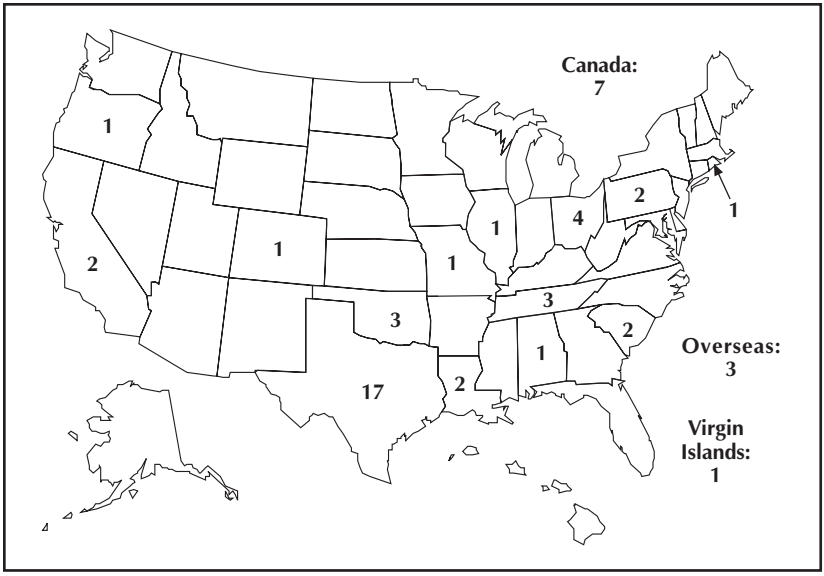

Figure 1. Locations of the projects

Although the safety performances and sizes of the projects ranged widely, it is apparent that the safety performances of most projects are much better than the construction industry average of about 8.2 for the year 2000. It was in this context that the analysis was intended to identify those practices of owners that had a particularly strong impact on the resultant TRIR. It may not be surprising to expect better safety performances on projects where CII members are the project owners. This research, however, was not restricted to projects involving CII members. This perhaps accounts

for the relatively broad range in TRIRs. The TRIR of CII members was reported as being about 1.03 in year 2000, significantly better than the industry average. This research investigated those owner practices that had a direct impact on influencing the safety performances realized on projects.

Although the 59 projects provided OSHA recordable injuries, only 46 were able to provide information on all injuries, including lost-time injuries, OSHA recordables, and first-aid injuries. All injuries were tallied by severity category, and the ratio between different types of injuries was determined as shown in the injury pyramid in Figure 2. The ratio that exists between injuries on the basis of severity has been discussed for many years. While these ratios may vary, the general trend is relatively consistent. Note that the pyramid could be simplified by reporting the ratio between ratio of lost-time, OSHA recordable, and first-aid injuries as being roughly 1:10:300.

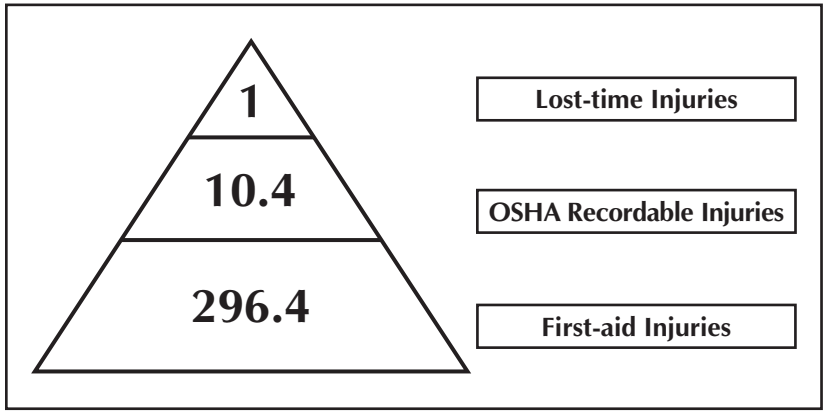

Figure 2. Injury pyramid for the projects

Theoretically, the size of the project, labor arrangements for the project, type of project, and other characteristics of the project are all related to the safety performance of the project. These factors may be influenced by the owner to some extent and therefore were also analyzed.

Shutdown projects

Although new projects do not show a significantly different safety performance when compared to renovation projects, shutdown projects were found to have poorer safety performances. The average TRIR of the eight shutdown projects included in this research had higher TRIRs than the other projects (see Figure 3).

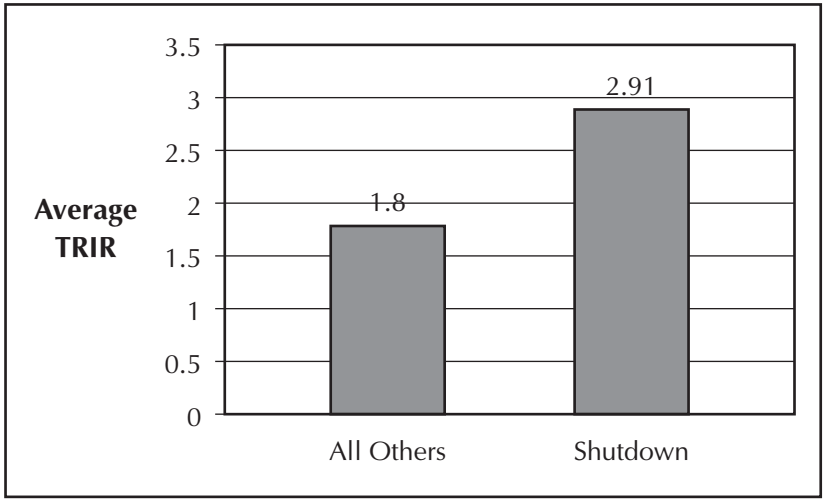

Figure 3. Injury rates of shutdown projects and all other projects

Shutdowns are characterized as having tight schedules, significant amounts of overtime work, frequently working multiple shifts, and generally having a rapid buildup of the work force. When workers and managerial personnel work extended hours for one or two months, the possibility of human errors increases, and so will the probability of injury causation.

Public or private project

The comparison of the TRIRs of public projects and private projects, excluding the shutdown projects (which are all private projects), is illustrated in Figure 4. Some public agencies, especially Federal agencies, may require the contractor to comply with their own safety manuals in addition to the OSHA 1926 regulations. However, the involvement of the owners in the safety management of the public projects was generally viewed as being minimal when compared to owner involvement on private projects.

Petrochemical and manufacturing projects

Petrochemical projects, which accounted for nearly half of the projects analyzed (30), had the best safety performances (see Figure 5). Note that the shutdown projects have been isolated in the figure in order to provide an accurate depiction of the differences between the safety performances between petrochemical and manufacturing projects. Petrochemical owners interviewed consistently reported having strong upper management commitment to construction safety and as having successfully integrated safety into their company cultures. They have a clear understanding of the zero injury philosophy, and jobsite responsibilities are defined to strengthen the safety culture.

Safety performance on manufacturing projects was consistently poorer than that of petrochemical projects. Note that residential and commercial projects are not included in this comparison, primarily because only a few such projects were in the entire sample.

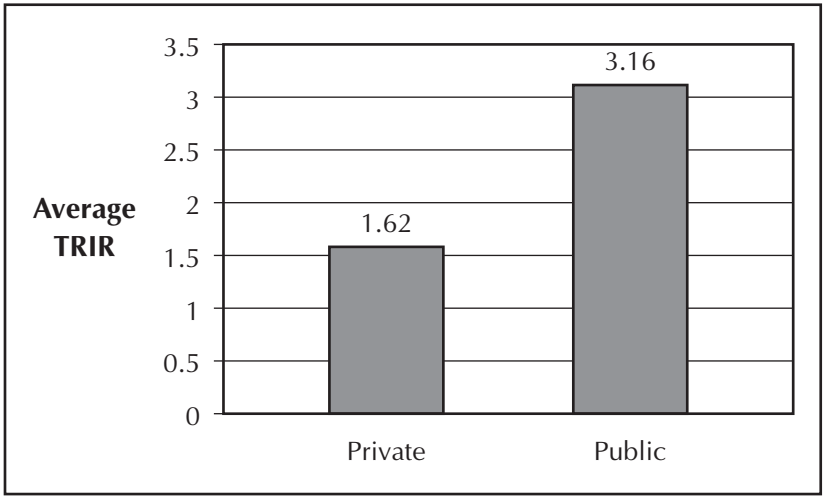

Figure 4. Type of facility owner and safety performance (excludes shutdown projects)

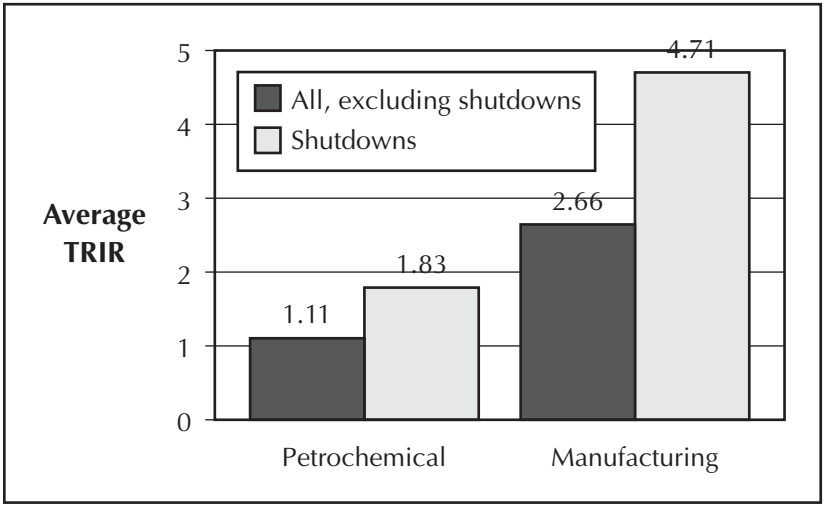

Figure 5. Type of project facility and injury rates

Union projects or open shop projects

A fairly even distribution of open shop projects, union shop projects, and merit shop projects was found in the database. In general, owners may have little to say about employing union or open shop contractors as local conditions often dictate the type of firms that are available to perform the work.

"Merit shop" projects are those in which the labor posture is not a consideration in the selection of contractors. It is on the merit shop projects that both union shop and open shop contractors may be employed at the same time (see Figure 6). Since Canadian

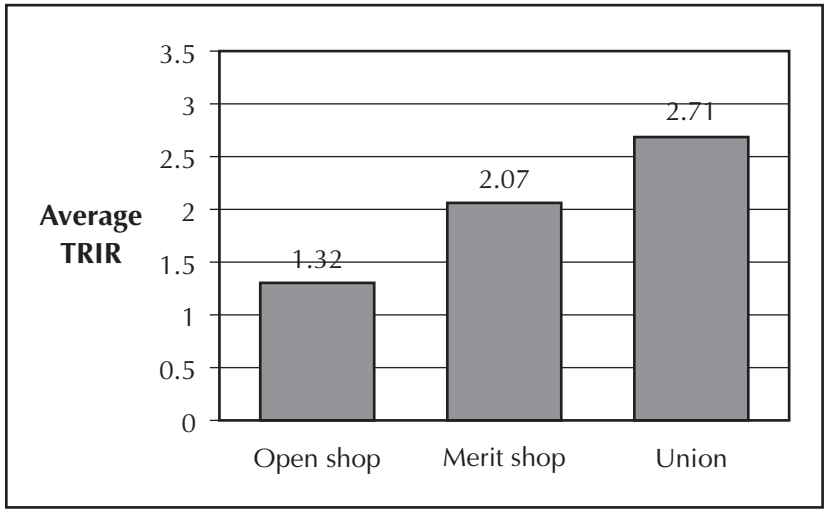

Figure 6. Type of labor and safety performance (U.S. projects only)

projects in the sample were all union shop and since international projects are in environments different from those in the U.S., the figure presents information on only the U. S. projects. Figure 6 shows that safety performance in the database for this research was better on open shop projects than on union shop projects. Note that this same pattern of TRIR values was found to exist when only petrochemical projects (exclusive of shutdown projects) were examined.

Type of contract

Two aspects of the project contract were investigated in the study: type of agreement (how the owner would make payment to the contractor) and contracting methods (the contractual relationship between the owner and contractors). One reason that the agreement type should be considered when addressing project safety is that the contract establishes the basis by which the owner will make payments to the contractor. Essentially, the payments can be made on the basis of unit prices, a schedule of values (in lump-sum contracts) or a reimbursement of actually incurred costs. As safety can be enhanced through the concerted efforts of different parties (owner, contractor, and designer), the manner in which the contract defines their relationships might readily impact project safety.

For example, if the contractor has a close, long-term relationship with the owner, the owner and the contractor may be inclined to use a cost-reimbursable contract (job order contracting or cost plus). Under such contracts, the owner will reimburse the contractor's investment in safety. With greater support for the contractor's efforts in safety, there is less contractor reluctance to dedicate funds for safety.

Different approaches will influence the safety efforts of all parties. One method of enhancing safety is to conduct a constructability review as part of the design process. This review helps to coordinate the safety efforts of designers and the work performed on site. Comparisons were made of the safety performances of design-build projects with projects constructed under other contracting arrangements. Design-build firms, including engineering, procurement, and construction (EPC) and engineering, procurement, construction, and management (EPCM) firms, have a direct incentive to focus on construction safety during the design phase as it is their own employees that are impacted by the design efforts. In the general contract arrangement, the design

team is separate from the construction effort and typically does not address construction safety in the design. The owner could impose duties to evaluate safety on the design firm, regardless of the contract type, but this was not examined in the study. Results (see Figure 7) show that design-build projects had significantly better safety performances than did projects with the projects using the general contract approach. The other types of contract arrangements could not be evaluated because of insufficient responses from those types of projects.

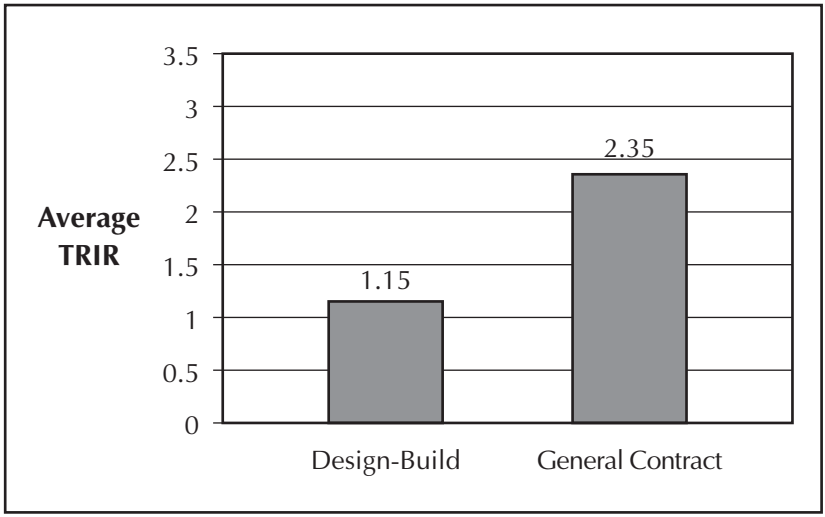

Figure 7. Type of contract used on the project

Size of the projects

The size of the project may indicate the complexity of conducting site work and coordinating the related safety efforts. Size might be measured in terms of total constructed cost, the number of subcontractors on site, the number of workers on site, or the number of worker hours expended. In this research it was

felt that the total number of workers on site gave a more accurate portrayal of the difficulty of implementing a safety program. On small projects, with fewer hours of worker exposure, simpler designs or engineering plans, and a smaller work force, safety efforts can often be more effective. On larger projects (with more than one million hours of worker exposure), safety performances may also be expected to be good since the safety program may use more advanced techniques to promote safety. Despite the complexity involved, safety performances on these large projects were quite good (see Figure 8). This held true throughout the sample for all large projects, including shutdown projects, petrochemical projects, and all large projects combined.

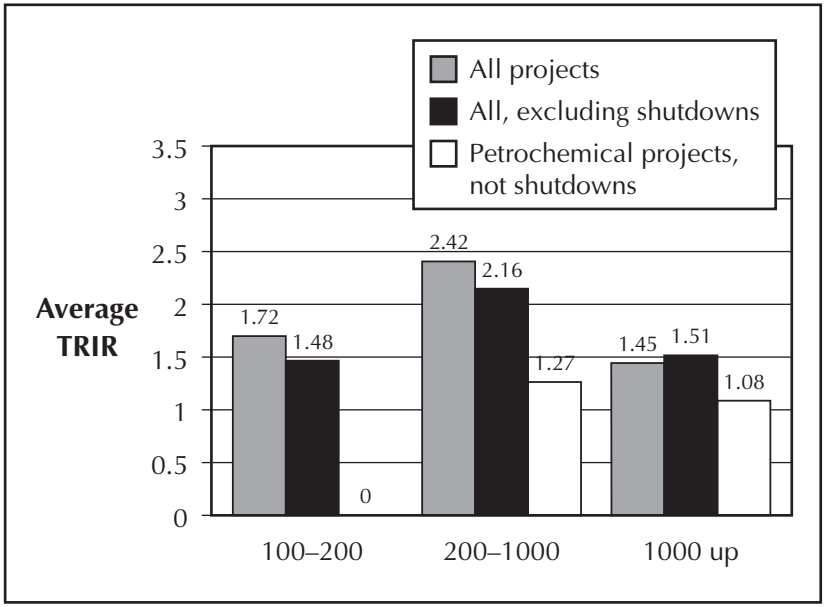

Figure 8. Worker hours expended and safety performance
(In thousands of hours)

Work shift and workdays

The number of shifts worked or the number of workdays worked are often dictated by schedule requirements. Tight deadlines often mean that overtime work will be a requirement. On the projects involved in this research, it was found that projects with one shift have significantly better safety performances than those with more than one shift (see Figure 9). Projects with five or four workdays (primarily those working four-tens) a week had significantly better safety performances than those working more than five workdays (see Figure 10).

Owner's selection of the contractor

In this research, it was found that most owners emphasize the importance of selecting safe contractors in the pursuit of the zero-injury objective. While all owners seem to be aware of the need to select safe contractors, they differ in the approaches used to accomplish this objective. Most private owners will not consider awarding contracts to contractors with bad safety performances. Some larger owners maintain their own database of the safety performance history of all parties with whom they have contracted. From this, they develop and maintain an approved contractor list and only these firms are given the opportunity to submit bids on their projects. Demonstrated safety performance is a major prerequisite for many contractors to be awarded contracts.

Preferred contractors list

Projects on which contracts were awarded through competitive bidding or through a negotiated process do not show any statistically significant difference in their safety performances. Similarly, projects for which the contracts were awarded to contractors on a preferred contractors list (TRIR=1.88) reported safety performances that were not significantly different from those for which the bidding was open to all interested contractors (TRIR=2.26).

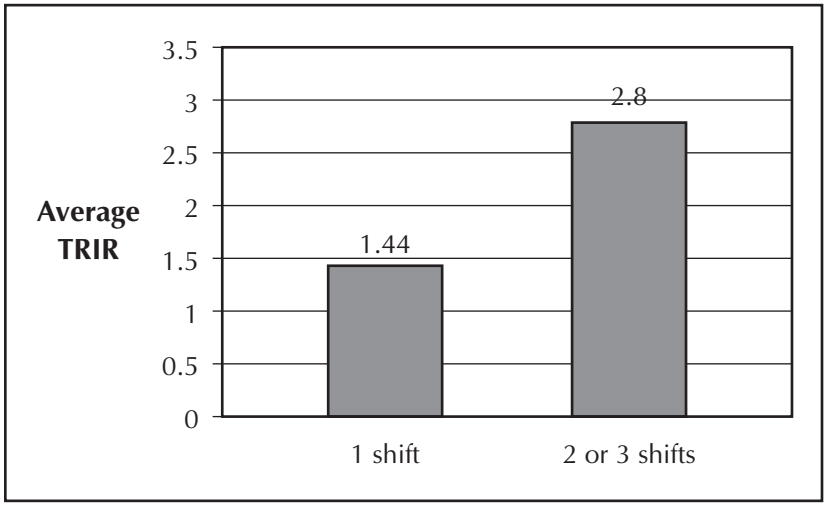

Figure 9. Number of shifts worked and safety performance

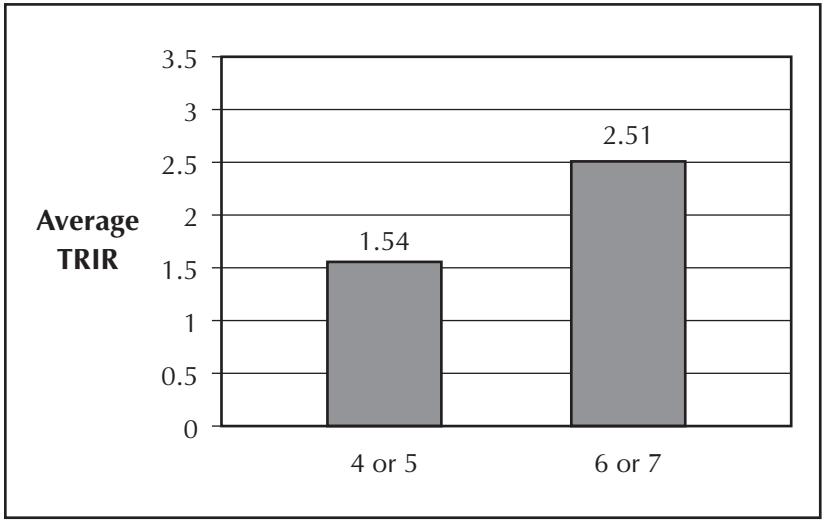

Figure 10. Number of days worked per week and safety performance

Importance of safety during selection of contractors

To get an impression of the importance placed on safety, each owner respondent was asked about the extent to which safety played a role in the evaluation of contractors in the selection process. The findings show that projects had better safety performances when the owners placed a higher priority on safety when reviewing contractors (see Figure 11).

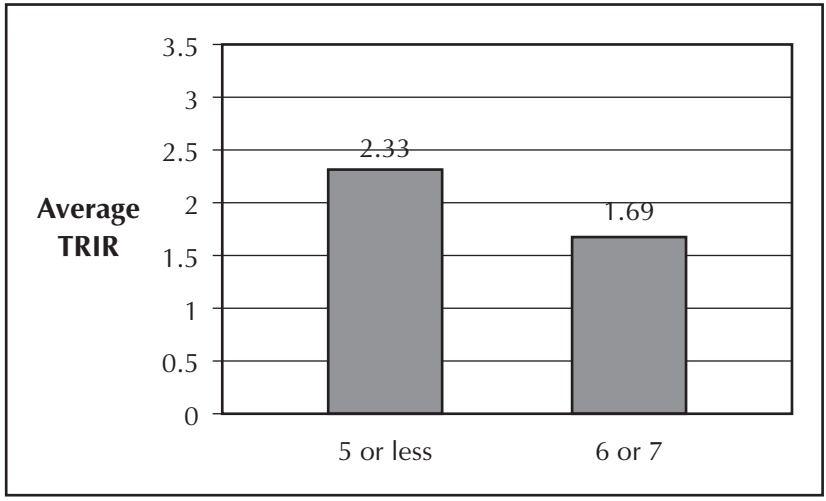

Figure 11. Emphasis placed on safety in the overall review of contractors (7 is the most important)

Criteria used to evaluate safety performance of contractors

The research shows that owners used varying measures of safety performances. One such measure used was the experience modification rating (EMR) on the workers' compensation insurance. The EMR has been widely used in the past few decades, but has lost favor with some companies as a viable indicator of safety performance. While the EMR is based on three years of loss history, its reliability as a measure of safety performance is dramatically compromised by the number of workers employed by the firm and by the hourly wages paid to the employees. Thus, it is difficult to

make valid comparisons between firms, especially if they differ in size or in the wages they pay. Most owners stipulate that they will not employ a contractor whose EMR is greater than 1.0. Some owners recognize the shortcomings associated with making comparisons between companies on the basis of the EMR. Generally, owners will not focus on a single measure, but will try to assess the overall safety performance of contractors based on a number of measures. Viable measures include the contractor's safety program and the qualifications of the safety personnel.

The EMR is considered to be a lagging indicator in that it represents historical data rather than a current indication of a contractor's safety commitment. The TRIR is also a lagging indicator, but is a measure that is widely utilized. The TRIR is a measure of how many failures have occurred, as each injury represents a failure on the part of the contractor. The results of this research show that safety performances of projects are significantly better when the owner uses TRIR as one of the measurements for evaluating contractors (see Figure 12). Those owners using

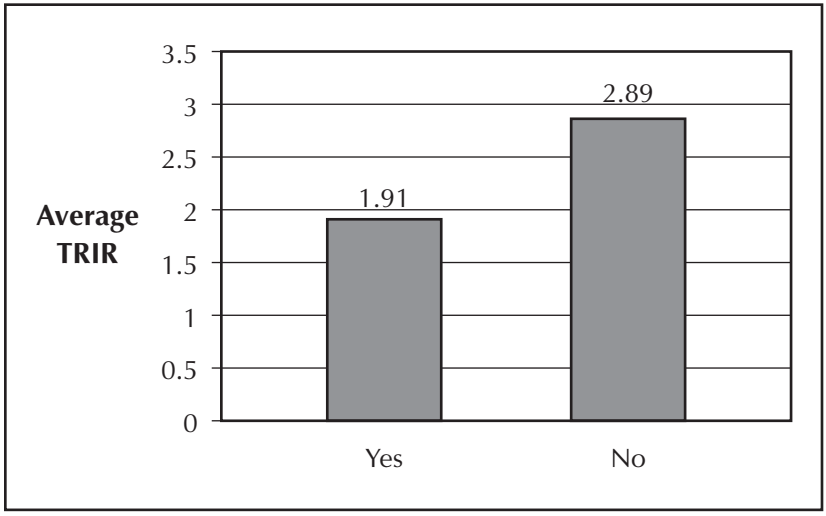

Figure 12. Is the TRIR used to evaluate safety performance of contractors?

the TRIR were asked if a threshold value of TRIR was established, namely a value above which safety performance was deemed to be unacceptable. The safety performances of projects with more stringent TRIR requirements (threshold values no greater than 2) tend to be significantly better than on projects using more lenient threshold values, and these are better than where no TRIR limits are established (see Figure 13). The findings indicate that setting a stringent objective may result in better performance. Conversely, setting a weaker objective may result in a less strong performance. Note that the category "none" includes projects that either do not use the TRIR as a requirement and also projects that use the TRIR, but that do not establish a specific threshold value.

Qualifications of the contractor's safety personnel and those of the project management team are criteria that were used by some owners for the selection of contractors. The more proactive owners reviewed these qualifications by conducting personal interviews and by making site visits. The resultant TRIR was found to be lower on projects where the owner's had a practice of considering the qualifications of the contractor's safety personnel and the qualifications of the project management team (see Figure 14).

Further analysis was conducted on the merits of using the following proactive criteria to measure safety performance:

- Qualifications of the safety staff of the contractor
- Qualifications of the project management team of the contractor
- Quality of the overall safety program of the contractor

The impact of using none or all three was examined. The analysis essentially determined the TRIR of those projects when the owners used all three measures in their assessment of contractors, when owners used less than three measures, and those that did

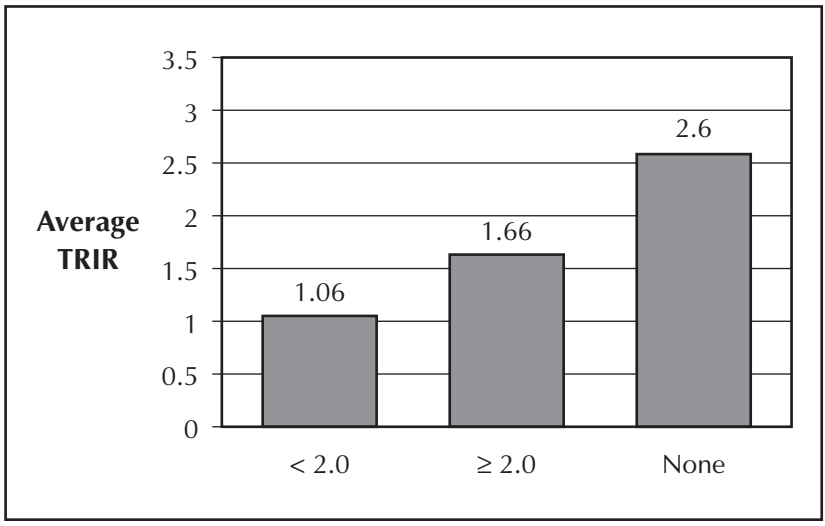

Figure 13. Threshold value of TRIR set for contractor safety performance

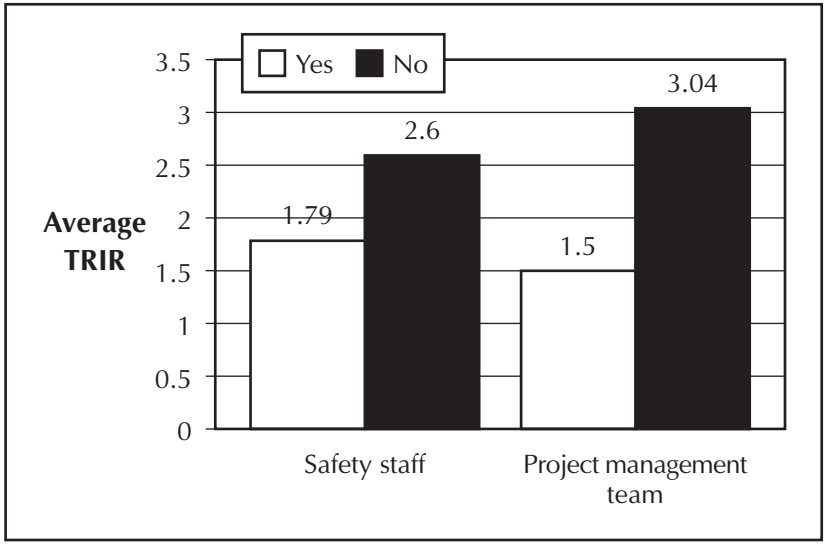

Figure 14. Whose qualifications are reviewed when evaluating contractors for safety?

not evaluate contractors on the basis of safety when making their selection of the contractor. It should be noted that most owners (35) used all three leading indicators. The relationship between the number of proactive criteria used and the resultant safety performances is shown in Figure 15. From this, it is evident that the use of all three proactive criteria is associated with better safety performance than when only one or two measures are used.

By using more proactive criteria for safety evaluations, owners make it clear that safety is important. As shown in Figure 16, when safety does not influence the contract award or when fewer proactive criteria are used, safety performances on the projects are not as good.

Owner's contractual arrangement

Today, safety and security provisions are often found in the general conditions or the supplementary provisions of the contract. In this study, the contracts between the owners and contractors were investigated. The primary focus was on the safety requirements established by the owners. Findings show that contractual arrangements influence the safety performance realized at the project level.

Safety requirements in contract

The construction contract may impose a variety of requirements on the contractor. Only the provisions clearly focused on safety were examined in this research. Many different requirements were noted to be included in the contracts. Only those requirements related to better safety performances are presented.

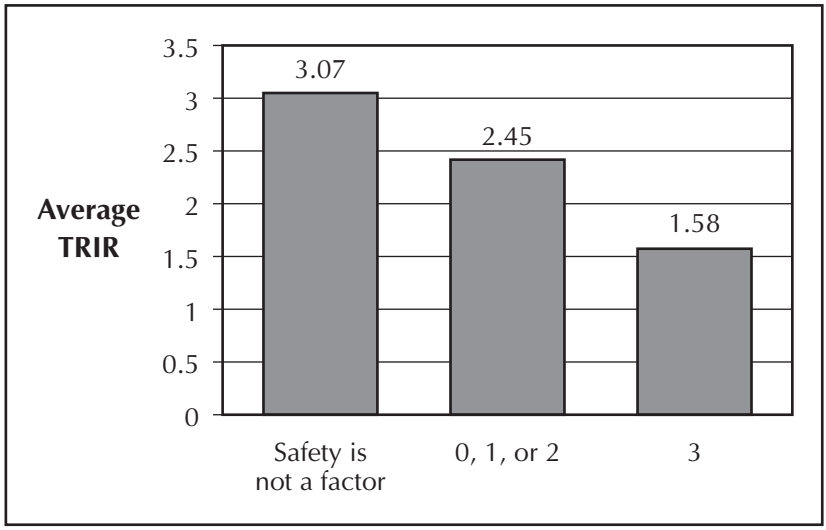

Figure 15. Number of proactive criteria utilized for evaluating contractors on safety?

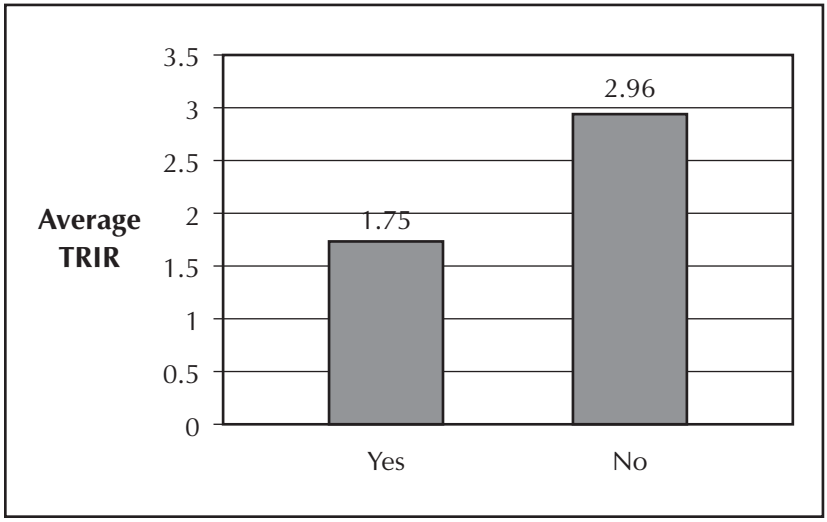

Figure 16. Contract requires the contractor to place at least one full-time safety representative on site?

Two particular provisions were noted to be associated with better safety performances. One was that better safety performances were noted on projects where the contractor was required to assign at least one full-time safety representative to the construction site (see Figure 16). Also, better safety performances were noted on projects where the contractor was required to submit the resumes of the key safety personnel (to be assigned to the project) for the owner's approval (see Figure 17). Impacts of other leading indicators used in the contractors are shown in Figure 18.

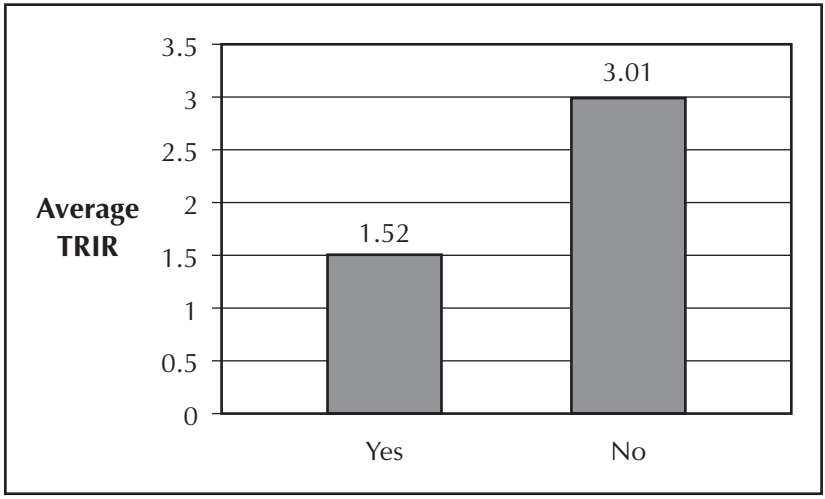

Figure 17. Contract requires the contractor to submit the resumes of key safety personnel for the owner's approval?

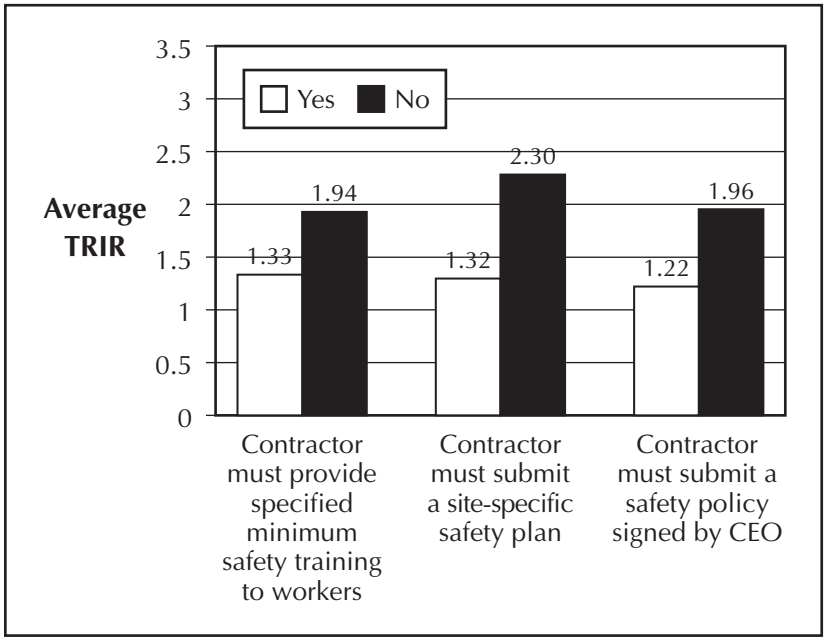

Figure 18. Other leading indicators used in the project contract (not statistically significant)

There were questions related to 16 different types of contract requirements. Among these, five were identified as being leading indicators:

- Contractor must place at least one full-time safety representative on the project.
- Contractor must submit the resumes of key safety personnel for the owner's approval.
- Contractor must provide specified minimum training for the workers.
- Contractor must submit a site-specific safety plan.
- Contractor must submit a safety policy signed by its CEO.

The data analysis showed a relationship between the number of leading indicator safety requirements and the safety performances realized on the various projects (see Figure 19). Projects on which more leading indicator safety requirements were imposed had better safety performances than projects with fewer leading indicator safety requirements.

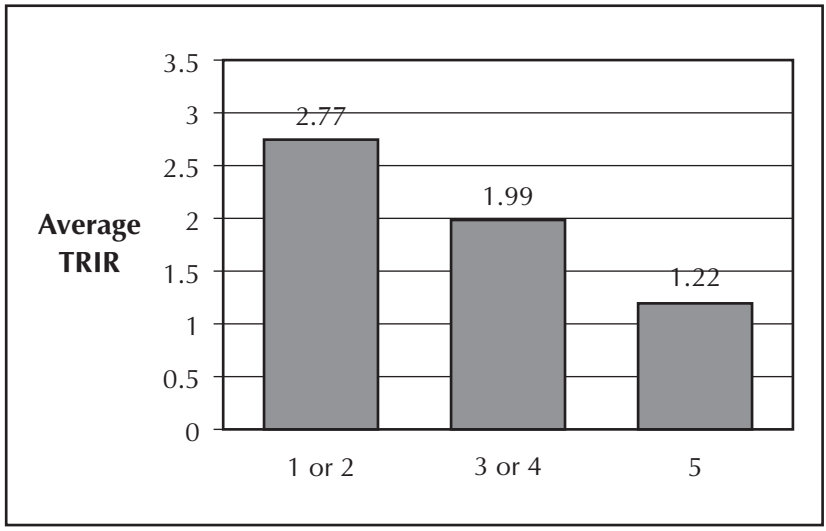

Figure 19. Number of leading indicator safety requirements included in the contract

Owner involvement during project execution

Several questions were asked about specific practices of owners that are intended to favorably influence safety performances of projects. These practices included owner participation in safety recognition programs, monitoring of safety performance, funding safety initiatives, accident reporting, accident investigations, safety training and orientation programs, and so on. Only those practices that showed a clear influence on safety performances are presented.

Safety program of the contractor

Questions were asked about specific safety program elements that must be included in the project safety programs of contractors. Fifteen possible safety program elements were listed in the questionnaire, including:

- OSHA specific regulations
- Specific safety training session
- Prime contractor's employees to have 10-hr OSHA cards
- Prime contractor's supervisors are trained in CPR and have first-aid cards
- Training on the hazards related to the tasks
- Pre-project safety planning
- Task-specific personal protective equipment (PPE) analysis
- Conduct regular safety inspections
- Incident reporting and investigation
- Emergency plan (medical and hazardous materials)
- Substance abuse program
- Regular safety meetings
- Safety responsibility defined for all levels
- Emergency response team maintained on the project
- Daily job safety analysis (JSA) conducted on the project site

The following items were significantly related with project safety performance (as shown in Figure 20):

- Emergency plan (medical and hazardous materials)
- Daily JSA conducted on the project site
- Substance abuse program

It was discovered that owners requiring more of these 15 elements had better project safety performances. While not statistically significant, the following inclusions in the safety programs were associated with noticeable differences in the reported safety performances:

- Specific safety training program
- Task-specific PPE analysis
- Safety responsibility defined for all levels
- Emergency response team maintained on the project

Owner monitors near misses on the project

Owners often monitor contractor safety performance on the basis of the TRIR. Since OSHA mandates that these records be kept, contractors can readily provide such information. A more proactive approach is for owners to monitor near misses (see Figure 21). By doing so, the future occurrence of such accidents may be prevented before an injury occurs.

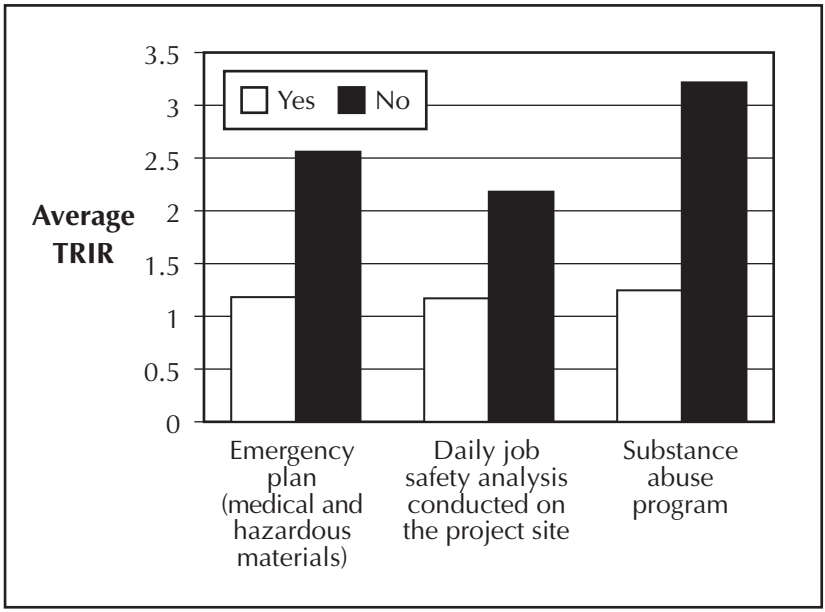

Figure 20. Key elements in the safety program

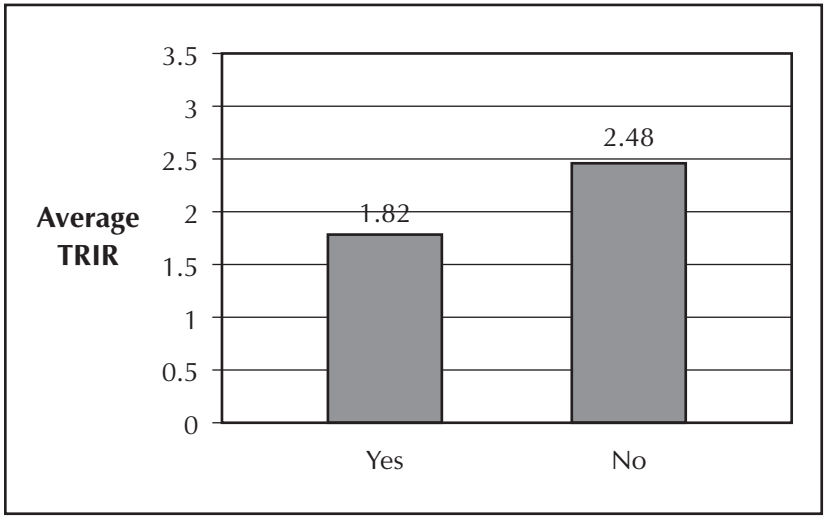

Figure 21. Does the owner's representative monitor near misses on the project?

Accident/incident investigations

Although all owners reported that they participated in the investigation of site accidents to a certain degree and generally maintained accident records, the manner of using these accident records makes a significant difference in project safety performance. Figure 22 shows that owners tracking individual safety performances of each onsite contractor had significantly better safety performances.

Evaluating the safety performance of each contractor can help in selecting safe contractors on future projects and in identifying any weaknesses in the current safety programs being implemented by each contractor. Additionally, if the owner incorporates the safety statistics of the contractor into its own safety performance statistics, the projects tend to achieve better safety performances (see Figure 23). By including the contractor's safety record in its own safety statistics, the owner essentially adopts the philosophy that any injuries on the project are a negative reflection on its own safety performance. Ideologically, the owner actually regards the contractor's employees as its own and recognizes the value of protecting and caring for them.

Safety recognition program

Positive reinforcement is one mechanism by which individuals are encouraged to repeat certain types of behavior. One such approach in safety is to implement a safety recognition program that rewards workers who have exhibited good safety behavior.

Owners held different opinions about safety recognition programs. Such a program essentially reflects the owner's philosophy about safety and their general concern for the well being of the workers. For example, some owners' representatives stated that safety recognition and safety incentives are the same, and certain

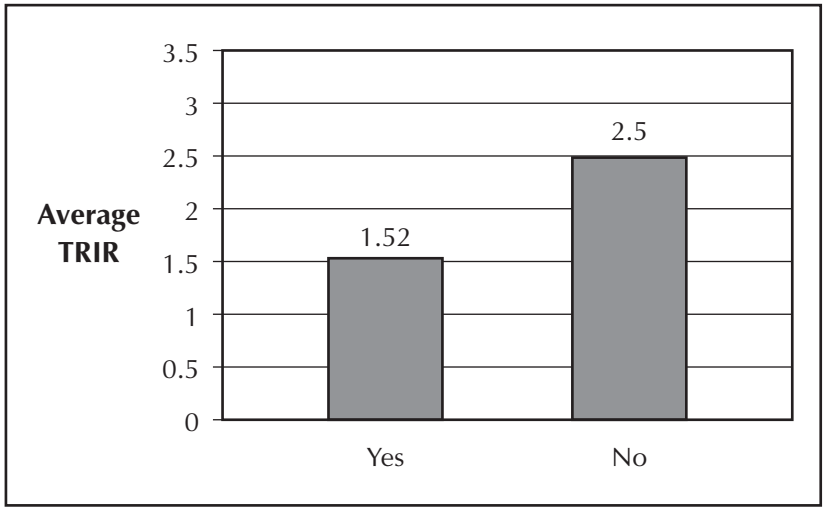

Figure 22. Does the owner maintain injury statistics by contractor?

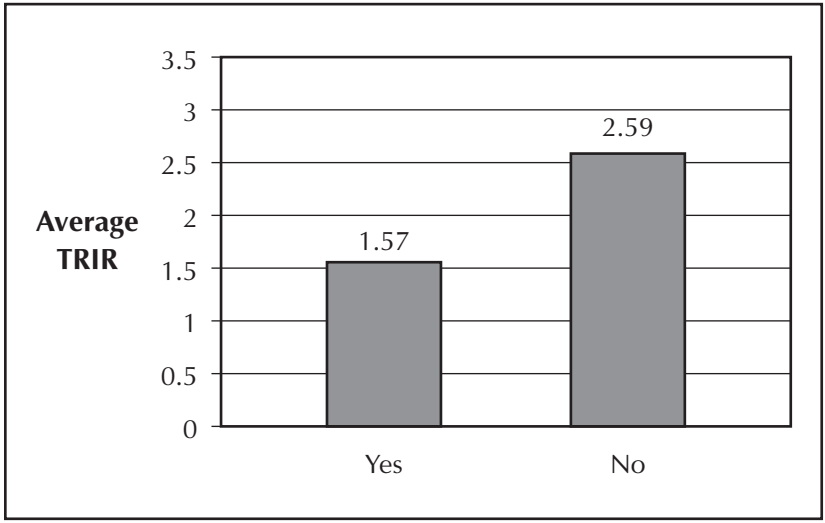

Figure 23. Are the contractor's safety performance statistics included in the owner's safety performance statistics?

monetary amounts are set aside to support safety bonuses and award workers who meet specified performance criteria. Some also set up incentives for the contractors. They believe when more funds are set aside, the safer the projects will be. However, other owners held the opposite view with the belief that safety cannot be purchased through economic incentives.

Analysis of the data shows that when the owner provides some funds above and beyond the contract amount to promote safety, the project is more likely to achieve better safety performance (see Figure 24). If the owner participates in the safety recognition program, the safety performance will also be better (see Figure 25).

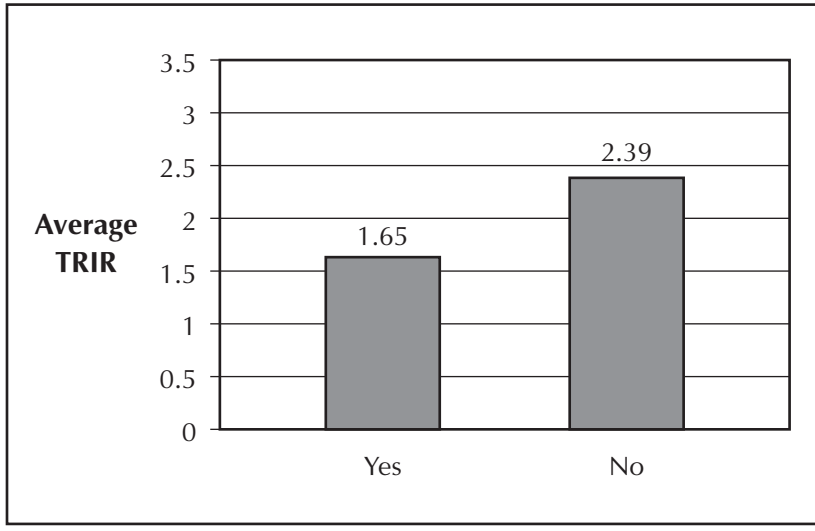

Figure 24. Are some funds provided to the contractor, above and beyond the contract amount, to promote project safety?

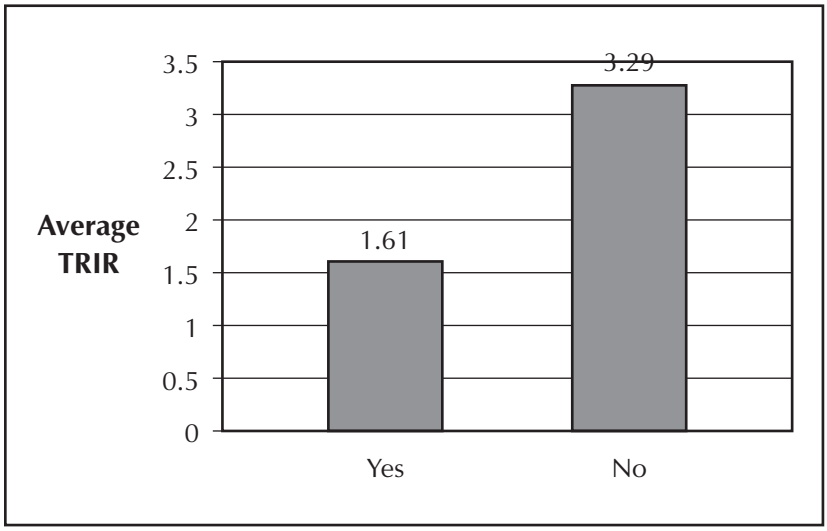

Figure 25. The owner participates in the safety recognition program

Safety education and training

New worker orientation and safety training are considered by many to form the core of any project safety program. Orientation is the foundation for effective implementation of many other safety programs. Training may be included in such safety initiatives as safety recognition programs, safety observation programs, job safety analyses (JSA), safety committees, and other programs that encourage worker participation.

Opportunities to provide ongoing training should be recognized and understood. The primary objective is to help workers to always be aware of safety and to develop safe working habits. This is important for the development of the project safety culture.

Owners can help make new worker orientation more effective and can also assist in the continuing safety training efforts in many ways. This is especially true for owners who are quite familiar with the hazards commonly encountered on sites. Owners can stipulate the minimum requirements of safety training, and the site safety representatives of owners can participate in safety orientation sessions. Owners can provide funds and personnel for the safety orientation of the workers, and can also assess the results of safety training by requiring a test to be administered at the end of each training session.

The results of data analysis support the fact that safety training can make a difference in the project safety performance. The methods employed to deliver safety training include showing videos, making owner and contractor presentations, and providing workers with reading materials. Of these, owner and contractor presentations were identified as being particularly viable. Figure 26 shows that when the owner is involved in the safety training, projects reported better safety performances. Also, refresher safety training for workers can make a difference in project safety performance. When a means exists to verify the comprehension of the safety orientation training received by workers, the safety performances are significantly better (see Figure 27). Generally, the owner will require a test or exam after the safety orientation session to verify the comprehension of the training.

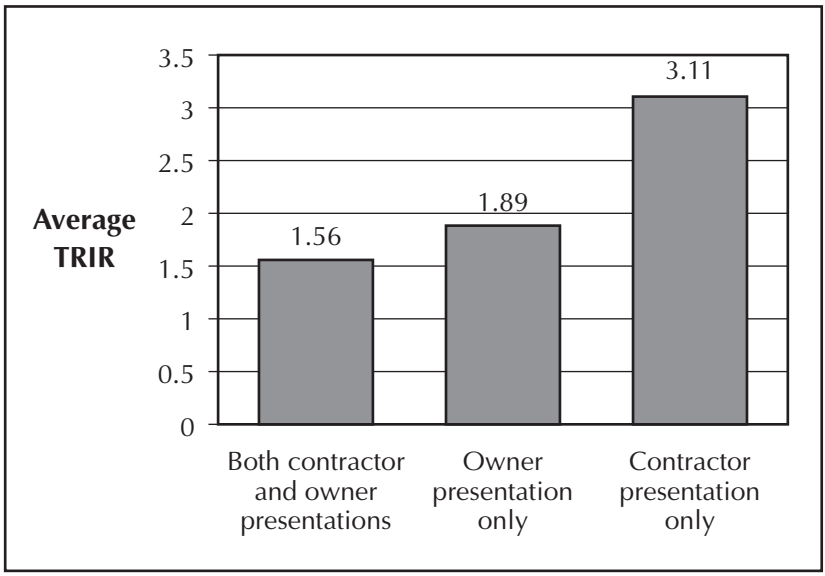

Figure 26. Safety training methods used on the project

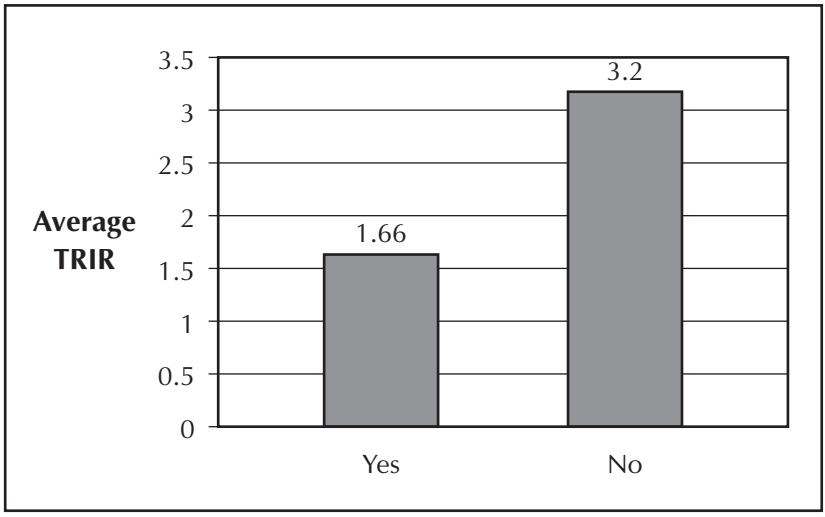

Figure 27. Is there any means of verifying the comprehension of safety orientation?

Responsibilities of owner's site representative

The owner's site safety representative is the person who expresses the owner's concerns for safety and helps to coordinate the contractor's efforts on safety management. The responsibilities and authority of the owner's representative will impact the safety performance of the project. On most projects interviewed, the owner would assign at least one manager as a full-time project safety representative. The responsibilities of the safety representative are quite similar on many projects. One of the responsibilities consisted of active participation in safety meetings. Active participation in safety meetings and/or tool-box meetings resulted in significantly better safety performances (see Figure 28).

The number of key safety activities performed by the owner's safety representative is related to project safety performance (see Figure 29). When the safety representative assumes more responsibilities, the project tends to achieve much better safety performance. The key activities, which are more commonly performed by the safety representatives, include:

- Enforcing safety rules
- Reviewing safety performance on site and submitting reports to the home office
- Monitoring pre-task analysis programs
- Participating in safety recognition programs
- Participating in safety and/or tool box meetings

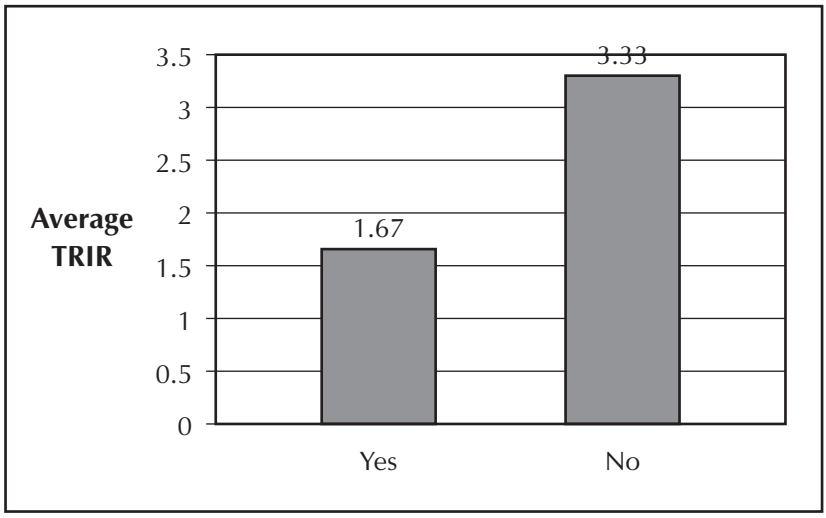

Figure 28. The owner participates in safety meetings and toolbox meetings

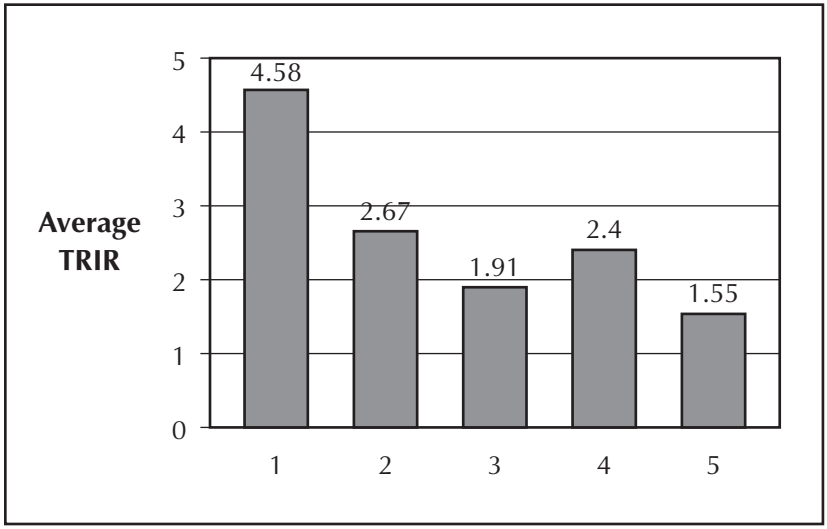

Figure 29. Total number of key activities performed by the owner's safety representatives

Another consideration relates to how the owner's safety representative monitors project safety performance. Nearly all owners check incident rates on projects, including lost workday injury rate, TRIR, and first-aid injury rate. Checking the near-miss rate and monitoring worker safety training records will help project safety performances (although this finding is not statistically significant). Checking safety inspection records was associated with significantly better safety performances (see Figure 30).

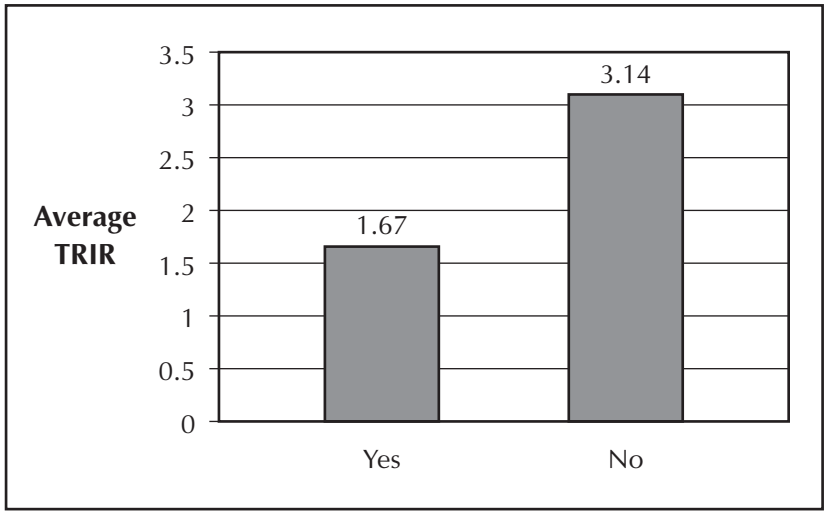

Figure 30. The owner's representative checks project safety inspection records on a regular basis

Also, when the owner's safety representative checks the project near-miss rate on a regular basis, the project tends to achieve better safety performance (see Figure 31). The leading indicator measures

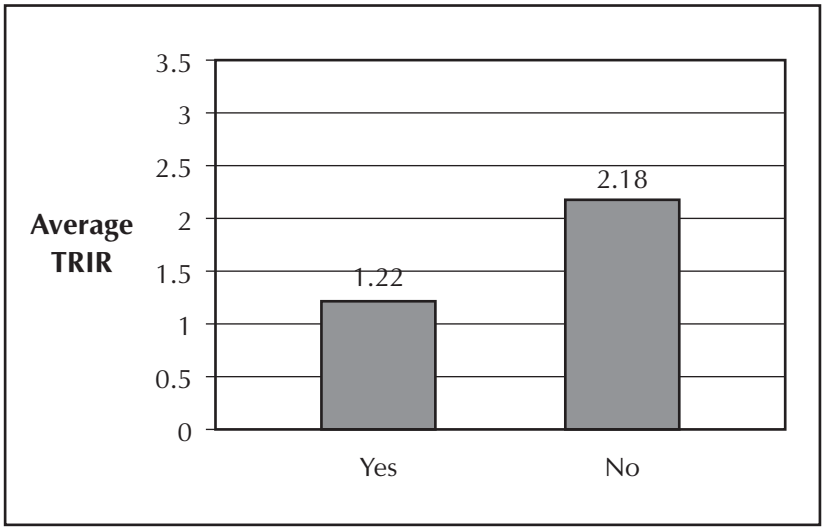

Figure 31. The owner's representative checks project near miss rate on a regular basis

were identified as (1) checking near-misses and (2) checking project inspection records. Statistical analysis shows that projects where the owner did not monitor either of these two leading indicators had poor safety performance (TRIR is averaged as 6.01). As to the first-aid injury rate, nearly 90 percent of the owner representatives in the study monitor the safety performance of the contractors on a regular basis.

Setting zero-injury objectives

As to the owner's expectations about safety performance, the results show that owners that establish specific safety expectations tend to have better safety performances on their projects, especially those owners who set zero OSHA recordable injuries as their safety objective before project commencement (see Figure 32).

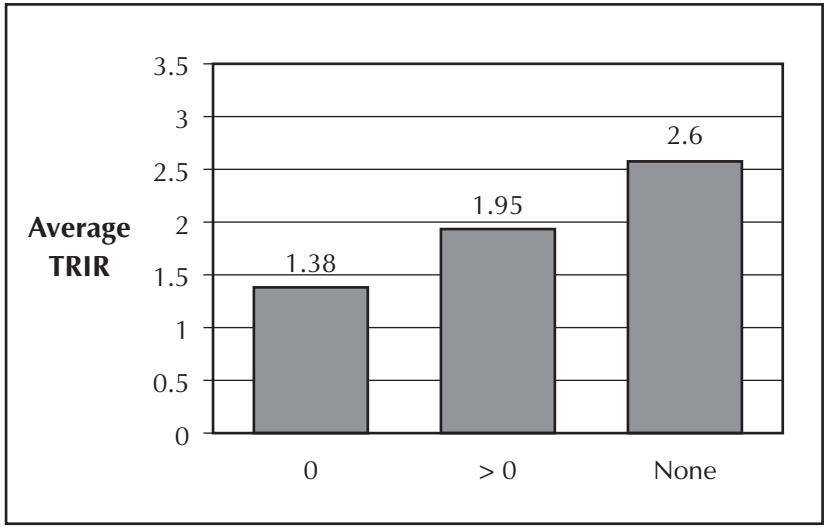

Figure 32. TRIR safety objective set by the owner before project commencement

3

Industrial vs. Commercial Construction: A Case Summary

Is there a logical explanation that industrial projects tend to have better safety records than do commercial projects? More specifically, is there some characteristic of commercial projects that they cannot achieve the level of safety performance achieved on industrial projects? The experience of one particular construction company provides a clear answer to these questions and that is a clear "No." This company has two large divisions, namely an industrial division and a commercial division. From 1992 to 2002, these two divisions worked nearly 100 million hours, with the industrial division being somewhat larger than the commercial division.

In 1992, the safety performances of these two divisions were quite different. The OSHA recordable injury rate of the industrial sector was 3.26 while the injury rate of the commercial sector was 9.74. At this point in time, the industrial sector had implemented an aggressive safety program while the commercial sector was not as fully engaged in safety. Over the next years, the commercial sector began to adopt a more proactive stance on safety. This effort has continued to where the safety performance of the commercial sector has now outpaced that of the industrial sector. While the industrial sector showed a sustained improvement in the injury frequency rate, the commercial sector showed much more dramatic improvements. This is shown in Figure 33 (next page).

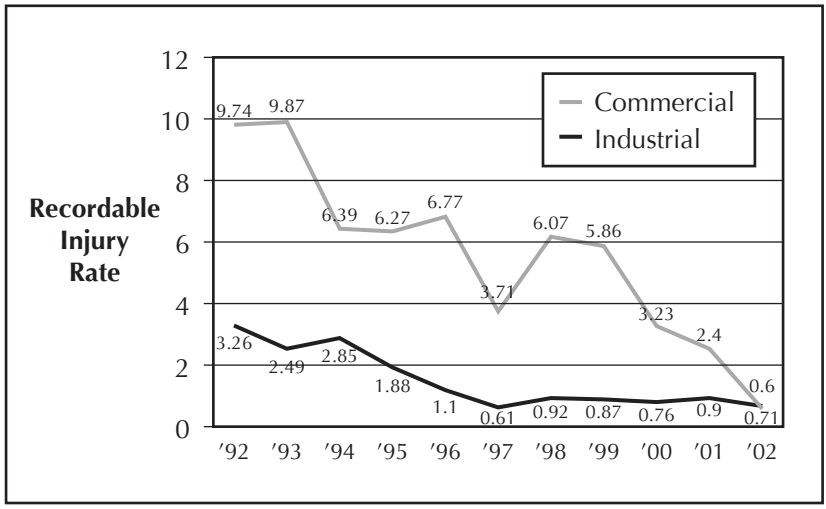

Figure 33. One Corporate History Example of Safety Performance

4

Summary

This research focused on the owner's involvement in safety management as demonstrated through the selection of safe contractors, inclusion of safety requirements in the contract, and active participation in safety during project execution. Better safety performances are related to the following practices of the owners:

- Project context. Certain project characteristics were associated with better safety performance, including: petrochemical projects, private projects, open-shop projects, projects with design-build contracts, projects of fairly large or small size, project working one shift, and projects working five or less workdays.
- Careful selection of safe contractors. Proactive criteria are used to evaluate and select contractors by owners aggressive in safety. These include TRIR on the past projects, qualifications of the contractor's safety staff, qualifications of the contractor's project management team, and the quality of the contractor's overall safety program.
- Contractual safety requirement. Contractual safety requirements should clearly convey the owner's emphasis on safety and the owner's expectation of a safe project. Five contractual requirements were identified as being leading indicators, and they are listed as follows:
  - Contractor must place at least one full-time safety representative on the project
  - Contractor must submit the resumes of key safety personnel for the owner's approval
  - Contractor must provide specified minimum training for the workers
  - Contractor must submit a site-specific safety plan
  - Contractor must submit a safety policy signed by its CEO

- Owner's proactive involvement in the safety practices of projects. In this study, the key measurements employed by the owners with better safety performances are identified as:
  - Owners set their expectations on safety from the beginning, especially the zero-injury objective.
  - Owners impose requirements on the safety program developed by the contractors and emphasize specific items, including: emergency plans (medical and hazardous materials), daily JSAs (job safety analysis) conducted on the project sites, and substance abuse programs.
  - Owners monitor near miss rates and the safety inspection records on the projects, in addition to other types of injury statistics (TRIR, lost-time injury rate).
  - Owners maintain the accident statistics by contractors on their projects, and include the contractor's injuries in their own accident records.
  - Owners establish a behavior-oriented safety recognition program and contribute funds to the program.
  - Owners actively participate in safety training and orientation and verify the comprehension of the training (such as by testing).
  - Owners assign a full-time safety representative on site with various responsibilities including: enforcing safety rules; reviewing safety performance on site and submitting reports to the home office; monitoring pre-task analysis programs; participating in safety recognition programs; and participating in safety and/or tool box meetings.

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Owners' Role in Construction Safety Project Team

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